Vol. 8. Parts 2 & 3.

Rubber Research Scheme (Ceylon)

Combined

Second & Third Quarterly Circulars

for 1931

August, 1931.

IMPERIAL MYCOLOGICAL INSTITUTE
17 OCT. 1931

H. W. CAVE & CO., PRINTERS.

LIST OF CONTENTS.

NOTICE.

Owing to a temporary shortage in the Technical Staff of the Rubber Research Scheme (Ceylon), it has been considered desirable to combine the 2nd and 3rd issues of *The Quarterly Circular* for 1931, and these are herewith issued together.

REPORT OF THE COMMITTEE ON SOIL EROSION

THE attention of all Rubber planters is directed to the Report of the Committee on Soil Erosion published as Sessional Paper III—1931.

During the past decade the attention of agriculturists in Ceylon has been repeatedly and often forcibly drawn to the serious consequences of unchecked soil erosion, but the loss to estates by removal of surface soil and the damage to public works due to soil wash and accelerated run-off have never been more strikingly represented than in this Report. After visiting all the main planting districts and eliciting the views of prominent agriculturists the Committee concludes that the serious nature of the problem of soil erosion in Ceylon is generally appreciated, but that realisation has not always been translated into action. The Committee recognises the excellent anti-erosion work which has been done on estates during the last few years, but considers that in too many cases full reliance is placed on methods of secondary importance and limited efficiency. Chapters IV and V, in which the views and recommendations of the Committee are set forth, are therefore of special interest.

The outstanding fact to which the Committee draws attention is that soil erosion should be checked at its source, and that this can be effectively done only by the provision of a ground cover. The Committee is unanimous in recommending the establishment of a creeping cover plant, whether the main crop be Tea, Rubber, or Coconuts. Earthworks, such as stone terraces, silt-pits and drains, should only be regarded as constituting a second line of defence to cover the imperfections of the ground crop. Due recognition is given of the excellent bunded drains, contour platforms, contour trenches, etc., adopted by various prominent planters to check erosion, but in so far as such systems are designed to collect the washed soil rather than to prevent its original movement, they should only be regarded as supplementary measures. All these systems are of great value in that they recognise the importance of retaining the water on the land and allowing it, with its dissolved air, to percolate through the soil, rather than leading it off by the shortest possible route. The retention of water on the land is particularly desirable on Rubber estates since *Hevea*, in order to yield freely, has a high water requirement. The establishment of a ground cover, together with planting on contour terraces or in contour drains, seems to solve the problem of soil erosion on Rubber clearings.

Numerous objections to the use of a ground cover on tea estates were advanced by practical planters, but the Committee considers that most of these objections are based on preconceived notions and prejudice. On Rubber estates, on the other hand, the only objection of any consequence advanced against the universal establishment of a cover crop is the encouragement which such a cover affords to the spread of root disease. This objection is valid and is undoubtedly supported by facts. The Committee considers, however, that the undoubted benefits conferred by a ground cover justify the assumption of the risk, and it is noted that planting opinion is in favour of retaining a cleared space around each tree. The Committee might have added that areas known to be affected with root disease, particularly *Fomes lignosus*, should be kept strictly clear of all cover.

If there are no important objections to the general use of ground covers on Rubber estates, there is, however, a serious stumbling-block experienced by many planters viz., the difficulty of establishing and retaining a cover in certain areas. The Committee points out that in many cases the failure with cover crops is due to the non-recognition of the necessity of adopting cultural methods with a ground cover as with the main crop. Our knowledge regarding the requirements of leguminous covers in old washed-out Rubber soils is, however, limited, and the Rubber Research Scheme has important work to perform in investigating the causes of failure and in discovering alternative species to replace or supplement *Dolichos Hosei* (*Vigna*) under mature Rubber. The Committee suggests various other lines along which research may profitably be conducted, but stresses the fact that the adoption of measures against soil erosion should on no account be delayed pending the completion of these investigations. Further research and practical experience may cause certain views to be modified, but in the meantime the basic principles laid down in the Committee's recommendations are unquestionably sound.

After serious consideration the Committee has decided that it is undesirable to recommend Government to enforce measures of soil conservation by means of legislation until the possibilities of persuasion, propaganda and example have been exhausted, and considers that the matter should be reviewed five or seven years hence. This decision implies confidence in the willingness and ability of the agriculturists of Ceylon to put into practice the recommendations set forth in the Report, and it is especially the duty of those responsible for the management of the larger estates to see that this confidence is not misplaced.

R. K. S. MURRAY,
Mycologist,
Rubber Research Scheme (Ceylon).

FURTHER SULPHUR DUSTING EXPERIMENTS AGAINST *OIDIUM*

R. K. S. MURRAY, A.R.C.Sc.,
MYCOLOGIST,
RUBBER RESEARCH SCHEME (CEYLON)

INTRODUCTION

IN 1930 the first experiments to be undertaken in Ceylon on the sulphur dusting treatment for *Oidium* were carried out on Kandanuwara Estate, Matale. A fair measure of success in the control of the disease was obtained, and a brief report on the experiments (with photographic illustrations) was published in Rubber Research Scheme *Quarterly Circular* Vol. 7, Part 2, 1930. A further series of experiments was carried out later in the year on Gonakelle Estate, Passara, and a full report appears in Rubber Research Scheme *Quarterly Circular* Vol. 7, Part 4, 1930. As was to be expected with an entirely novel method of treatment complete control of the disease was by no means obtained, but it was possible to deduce various reasons for this lack of entire success. Particular attention has been paid to these points in the recent experiments which, thanks to the courtesy of the Warriapolla Estates Company, Limited, have been carried out on the same field on Kandanuwara Estate as in 1930. The following is a report on these experiments:

THE EXPERIMENTAL AREAS

The treated area is a field of 30 acres of mature Rubber surrounded on three sides by Tea, and abutting, on the fourth side, on the area selected as a control. This somewhat isolated position was selected as being particularly suitable for the purpose since the risk of sulphur being blown on to the control area, and of *Oidium* spores being blown from the control to the treated area, was thereby reduced as far as was compatible with an efficient control. The trees are planted 30 ft. × 15 ft. on one side of a hill of moderate slope, and are well grown for the elevation. The field is well provided with paths so that the dusting operation is rendered relatively easy and quick. This area has been dusted during two successive "wintering" periods.

The area selected as a control occupies the side of a hill facing in the same direction as the treated field. The two fields are almost contiguous, being separated only by a narrow strip of land occupied by a road, buildings, etc. The slope of the land is somewhat steeper than that of the dusted field and the trees, though of approximately the same age, are, for the most part, smaller. The planting distance is about 18 ft. × 15 ft.

Before the dusting was commenced ten rectangular 16-tree plots were marked at regular intervals throughout each field. Each tree in these plots is separately numbered so that the condition of the foliage can be periodically examined and recorded. The plots are tapped on alternate days by an employee of the Rubber Research Scheme, and the yields for each plot recorded. The results as regards yield figures and foliage observations are not considered separately for each plot, but the summation of the results from the ten plots in each field is considered to be representative of that field as a whole. This method has been adopted owing to the impossibility, with the land available, of laying out plots in accordance with statistical requirements.

In 1929, before any sulphur dusting was commenced, both experimental areas were severely affected with *Oidium*, the extent of defoliation being approximately equal in the two fields. (See figures for 1929 on page 24.) The disease had been present since 1925, and defoliation severe since 1927. The undusted area may, therefore, be considered to serve as an effective control, so that any marked distinction between the two fields after sulphur dusting can be justifiably regarded as due to the treatment.

THE DUSTING OPERATIONS

As in the previous experiments the machine used was the Björklund Motor Duster. Very little mechanical trouble was experienced, but on several occasions the sulphur in the fan chamber became ignited and caused somewhat serious conflagrations. On only one occasion, however, was any damage done to the machine, and in this case a new fan had to be fitted. The cause of these fires is not clearly understood, but it is hoped that they will not recur after the machine has been re-conditioned. A machine with a closed fan-box would have an advantage in this respect.

With the exception of a trial application of "Sulphur Smoke", "Flotate" sulphur from the Kawah Poetih volcanic deposits in Java was used throughout. On the day on which "Sulphur Smoke" was used a light "drizzling" rain was falling, and despite these adverse conditions the sulphur formed an

excellent cloud. It is possible that under the same conditions "Flotate" sulphur, being hygroscopic, could not have been applied to the same advantage. In other respects, however, "Flotate" sulphur, when thoroughly dried, is at least as good as the American product, and is to be preferred on account of its lower price. Further experiments are necessary before the most satisfactory dusting powder can be determined, but in the meantime it is the writer's opinion that within limits (regulated by the particle size) the brand of dusting sulphur used is not of such great importance as the technique employed in the dusting operation.

In all, six applications were made to the experimental field as follows:

December 9th, 1930	"Flotate" @ 13 lb. per acre.
December 30th, 1930	"Flotate" @ 15 lb. per acre.
January 13th, 1931	"Sulphur Smoke" @ 14 lb. per acre.
January 29th, 1931	"Flotate" @ 15 lb. per acre.
February 10th, 1931	"Flotate" @ 15 lb. per acre.
March 3rd, 1931	"Flotate" @ 13 lb. per acre.
	Total 85 lb. per acre.

The work was supervised alternately by the writer and the Superintendent, Kandanuwara Estate.

The dusting operation has been described and illustrated in previous publications, and it is sufficient to state that working with 10 coolies the 30-acre field was dusted in an average time of $1\frac{1}{2}$-2 hours. This rate of progress would be considerably exceeded were a larger area to be treated.

It is of interest to record the progress of wintering in relation to the dates of application. When dusting was commenced on December 9th only an insignificant proportion of the trees had "wintered". *Oidium* could be found on such young leaves as were present, but the fungus had not attained its full virulence. The great majority of the trees shed their leaves during the latter part of December, and on January 13th, when the third application was made, 90% of the trees were completely bare. It may be remarked in passing that such a regular "winter" is unusual. During the next few weeks the trees were in progress of re-foliation. On February 10th the dusted field exhibited an excellent foliage in various stages of development. Although active *Oidium* was to be found throughout the field, the extent of defoliation was almost negligible, and most of the leaves were undistorted. In the control field, on the other hand, defoliation was very severe, and only the early winterers

had retained their leaves. A final visit was paid to Kandanuwara on March 14th. By this time the foliage in the dusted field was quite mature, and although "secondary" *Oidium* was prevalent throughout the field the applications were discontinued since it was thought that further leaf-fall was unlikely to occur. The condition of the foliage in the two fields on this date is further described below:

RESULTS

(a) *Foliage.*—The two photographs shown bear testimony to the striking difference in the appearance of the two fields on March 14th. Whereas the control area is practically leafless, having the appearance of Rubber during a normal "winter", the foliage of the dusted field, as viewed from a distance, would bear comparison with most areas at this elevation and, indeed, with many in the low-country. When comparing the two photographs it must be borne in mind, also, that the trees are more closely planted in the control than in the dusted field so that, other things being equal, a denser canopy in the former would be expected.

On March 14th an examination was made of every individual tree in the experimental 16-tree plots and the foliage was classified according to the intensity of *Oidium* attack. The figures together with those for 1929 and 1930, are shown on page 24. It will be noted that in the dusted field the proportion of trees classed as severely or completely defoliated (Classes E and F) has been reduced by the sulphur dusting from 56% in 1929 to 9% in 1931. In the control field, on the other hand, this percentage has risen from 51% to 76%. Correspondingly the proportion of trees in the dusted field in which leaf-fall is absent or very slight (Classes B and C) is 80%, as compared with 13% in the control field.

These figures indicate that the treatment has been extremely successful in preventing the most harmful effect of the disease viz: defoliation. Entire control of the fungus has, however, by no means been obtained, and "secondary" attack is still severe in comparison with low-country estates. It is probable that by continuing the treatment during March and April this attack on mature leaves could have been considerably reduced, but it is doubtful if such a procedure is an economic proposition. Although "secondary" attack is harmful in that the transpiration of the leaves is greatly increased, it is defoliation which imposes the severest tax on the vitality of the tree, and once the leaves are mature defoliation is not to be feared. On Kandanuwara the disease remains active throughout the greater part of the year so that at almost any time re-infection from neighbouring undusted Rubber will occur. In order, therefore, to keep the

Plate I. Kandanuwara Estate. Dusted field 14-3-31.

Plate II. Kandanuwara Estate. Control (undusted) field 14-3-31.

foliage healthy it would be necessary to make periodical applications throughout at least 9 months of the year, thus incurring an expenditure which would probably be disproportionate to the results achieved. In the most severely attacked areas the main aim of sulphur dusting must be to maintain the leaves on the tree, and it is probable that after two or three seasons the extent of "secondary" attack will also be reduced.

The present appearance of the control field is indicative of the worst effects of the disease if allowed to remain uncontrolled. Only the very early winterers have maintained their foliage, and even on these trees the leaves are small and distorted. As the result of the depletion of food reserves caused by continual defoliation many twigs and branches have died back, so that the number of branches left to bear leaves is greatly reduced. Consequently later in the year, when the trees recover to some extent, only the scantiest crowns are presented.

It must be mentioned that the above observations have been made at the time when there is the greatest contrast between the two fields. From about June to November *Oidium*, although not becoming entirely passive, loses some of its virulence, and the trees are able to recover to a great extent. Later in the year, therefore, most of the trees in the control field, instead of being leafless, will possess a thin crown of malformed leaves.

(b) *Yields*.—Comparative yields must constitute the ultimate criterion of the value of sulphur dusting as of any other treatment, and this matter is being investigated at Kandanuwara. Daily records of the latex and dry rubber are being taken from the ten 16-tree plots in each field, the same tapper being employed throughout. The results will be published later in the year, but in the meantime it may be stated that a large difference in yield in favour of the dusted field has been manifested during March, April, and May 1931.

QUANTITIES AND COSTS

The following is a full statement of the costs of the dusting operations. Owing to the small area involved it is difficult to give a significant figure for depreciation of the machine. This has been written down as Re. 1-00 per acre, which is considered to be a reasonable figure for work on a large scale.

	No attack	Mild to moderate "secondary"	Severe "secondary", little or no defoliation	Moderate defoliation	Severe defoliation	Complete or almost complete defoliation	Total
DUSTED PLOTS							
March 1931	0	64 (41 %)	60 (39 %)	17 (11 %)	10 (6 %)	5 (3 %)	156
April 1930	0	31 (20 %)	51 (33 %)	26 (17 %)	30 (19 %)	18 (11 %)	156
April 1929 (before dusting)	0	5 (3 %)	30 (19 %)	34 (22 %)	30 (19 %)	57 (37 %)	156
CONTROL PLOTS							
March 1931	0	1 (1 %)	18 (12 %)	16 (11 %)	19 (13 %)	96 (63 %)	150
April 1930	0	4 (3 %)	18 (12 %)	22 (15 %)	26 (17 %)	80 (53 %)	150
March 1929 *	0	49 (7 %)	162 (24 %)	126 (18 %)	147 (22 %)	197 (29 %)	681

* These figures (March 1929) refer to a different series of plots in another portion of the control field.

THE EXPERIMENT STATION, NIVITIGALAKELE

W. I. PIERIS, B.A., F.R.H.S.,
AGRICULTURAL ASSISTANT,
RUBBER RESEARCH SCHEME (CEYLON)

INTRODUCTION

SINCE the inception of the Rubber Research Ordinance of 1930 a large number of rubber producers, big and small, who were formerly not members of the Rubber Research Scheme have, by payment of cess, automatically become subscribers. Such proprietors and superintendents have not had access to the publications of the Scheme in which the progress of work at the Experiment Station, Nivitigalakele, has been recorded, and it is thought that a note describing briefly the objects and work at this Station would be of interest.

OBJECTS

The objects of the Station are primarily as follows:

(1) Proving of clones established from high-yielding trees on Ceylon estates with the object of discovering the best clones in the Island.

(2) Study of all points in connection with the process of budgrafting, influence of stock on scion, etc.

(3) Study of methods of opening up land for rubber cultivation, prevention of soil erosion, establishment and utilisation of green manures, etc.

SELECTION OF MOTHER TREES

Before an estate tree, reputed to be a high-yielder, is admitted into the Experiment Station "to be proved" it has to fulfil certain requirements and undergo what may be termed a period of probation. During this period the officers of the R.R.S. are largely dependent on the co-operation of estate superintendents in assisting them. The best yielders in a particular estate are primarily ascertained through the tappers and kanganies who generally know which of the trees they tap yield the most latex. These are reduced to a workable number by a primary selection by keeping the records of their yields in cubic centimetres of latex for 12 successive full tappings. Thereafter, over a minimum period of one year, the yield-record of each tree, whose latex is collected, coagulated, dried, and weighed separately, is kept by the Superintendent in special quarterly

return forms supplied by the R.R.S. The average weight of dry rubber per tree per tapping and the average weight per tapping per foot length of tapping cut are deduced, and the figures are plotted as graphs in specially designed books so that the relative merits of the trees can be judged at a glance. This information is further supplemented by the findings of the Botanist of the R.R.S. who visits the estate, takes bark samples and reports on the number of latex vessel rows, thickness of bark and other details for each tree. A selection of the best trees and those which satisfy the required standards is made and the selected trees are finally introduced into the Experiment Station by vegetative propagation. In due course the "buddings" will be test-tapped with a view to finding out whether the vegetatively propagated progenies of the selected mother tree are capable of reproducing the same or better latex-yielding properties in relation to their parent tree. A criterion of the yield of a mother tree, for selection, cannot definitely be laid down owing to influence of environment, etc; but broadly speaking a tree yielding 1 oz. of dry rubber per tapping per foot length of tapping cut is considered promising and a yield approaching 2 oz. per foot is very good.

BUDDING

The means employed for vegetative reproduction of *Hevea* is "bud-grafting". This consists of affixing a bud extracted from a branch of the selected mother tree to the bottom of a young seedling plant. Details of the method of budding will be found in a booklet on "The Budding of Rubber" by R.A. Taylor obtainable from the Secretary, R.R.S., Peradeniya, or in the article entitled "Budding Routine at Nivitigalakele" appearing in the current issue of *The Quarterly Circular*.

Budwood from the mother tree is obtained preferably from a branch that has been "pollarded" (i.e. previously pruned to produce fresh, succulent growth). Pollarding, however, interferes with yield records and is not advocated where extensive records are not already available. In such cases a method often adopted is to first establish a supply of budwood in the budwood nursery by taking a few buds from an unpollarded branch. If records of the mother tree in the meantime are found satisfactory the clone is budded out in the field from the budwood nursery. Buds are attached generally as follows:

(a) to a certain number of seedlings in the field which have been allotted to that particular clone;

(b) to 5-7 trees in the budwood reproduction nursery;

(c) to about 10 nursery seedlings (only in cases where the clone has been found to be difficult to bud and where "supplies" are likely to be required).

In most cases the seedling stocks on to which the buds are attached in the field are of known origin, and the fact that buds of a particular clone are grafted on to different stocks provides for the determining of "effect of stock on scion", if any.

THE CLEARINGS

The Experiment Station, situated 1 mile away from Matugama in the Kalutara District, is 69 acres in extent and has been opened up in 3 stages now referred to as the 1926, 1927, and 1928 clearings. All these clearings have been laid out on the contour platform terracing system except 4 acres in the 1928 clearing where the Denham Till trench system has been adopted.

The contour platforms, running horizontally at right angles to the slope of the hill, are 6 to 12 ft. in width and dip back into the hill at an angle of 1 in 5. They are 20 ft. apart at the steepest portion of each hill, and where a more gentle gradient has necessitated their divergence to 30 ft. or more an extra platform has been introduced. The trees on the platform are 18 ft. apart and extend in rows up and down the hill. The stocks were planted out originally as "stumps" (6 acres only), basket plants or "seed at stake" in holes 3 feet deep by $2\frac{1}{2} \times 2\frac{1}{2}$ and filled with top soil. All clearings have been budded in the field and only in cases of repeated casualties have stumps budded in the nursery been put out.

The 1926 clearing of 12 acres in extent contains 17 different clones. Eleven of these consist of approximately 100 trees each while the remaining six, planted as "budded stumps", are only represented by 3 to 20 trees each. The majority of the clones are Ceylon ones though two have been planted out as "budded stumps" from Java. They are as follows: *Eladuwa* 3, *Eladuwa* 5, *Govinna* 771, *Govinna* 1836, *St. George* 45, *Cuilcagh* 3, *Cuilcagh* 4, *Cuilcagh* 5, *Lavant* 28, *Lochnagar* 1/15, *Dalkeith* 3513, *Dalkeith* 19935, *Wawulugala* 197, *Heneratgoda* 2, *Heneratgoda* 401, *Java* 7, *Java* 18. The clearing was completely budded in July 1930 and by the end of 1931 some of its earlier buddings are expected to be ready for test-tapping.

The 1927 clearing of 17 acres consists of 19 Ceylon clones of approximately 100 trees each and is also completely budded. The clones are: *Kobowella* 41, *Kobowella* 42, *Eladuwa* 1, *Eladuwa* 4, *Palmgarden* 3183, *Palmgarden* 4849, *Yogama* 1H, *Yogama* 8Y, *Yogama* 21Y, *Frocester* 56, *Mirishena* 2, *Mirishena* 3, *Mirishena* 11, *Glendon* A4, *Madola* 15, *Madola* 110, *Millakanda* 10/2, *Beau Sejour* 5, *Talagalla* 2.

The 1928 clearing of 32 acres which is to contain 90 odd clones is being budded with 25 to 30 trees to a clone. Budding was commenced in April 1930 and about 25 clones have been

completed to date. The unbudded trees in the incompletely budded clones of the 1928 clearings were manured in February 1931, with a view to obtaining robust "stocks" for the season's budding. The manure used was a mixture of Nicifos and Muriate of Potash @ 1½ lb. per tree.

MARCOTS

In the 1927 clearing there are 77 trees "marcotted" off (i.e. vegetative propagation by ring-barking and "layering") the stocks of budded plants now growing in the 1926 clearing. In the 1928 clearing there are 21 others "marcotted" off the scions of the same budded plants. Thus there are three editions of plants as follows: (a) the stock growing on its own roots, (b) the scion growing on its own roots, and (c) the scion growing on the stock; and when tapped should give interesting results.

GREEN MANURES

The ground is well covered by a variety of leguminous cover plants both erect and creeping, and silt-pits opened along the lower side of the platforms receive the prunings thereof. The most promising among the erect cover crops established so far are *Clitoria cajanifolia*, *Tephrosia candida*, *Tephrosia noctiflora*, *Crotalaria usaramoensis*, *Sesbania cannabina*, *Indigofera arrecta*, and *Desmodium gyroides*. *Clitoria cajanifolia* has proved the easiest to establish, and responds excellently to pruning. It produces a large quantity of material for the silt-pits each year and spreads rapidly by seeding. It has been used for sowing along the edges of platforms to bind the soil and prevent the earth from slipping. *Dolichos Hosei* (*Vigna oligosperma*) *Centrosema pubescens*, *Calopogonium mucunoides*, and *Pueraria phaseoloides* have done best as ground covers. Though *Calopogonium* starts off well it looks as if *Vigna* and *Centrosema* are going to replace it as a permanent cover. *Pueraria* once established is an extremely rapid grower but its adaptability to shade has not been determined yet. Conditions on the whole may change a few years hence under much denser shade. Most cover crops have been grown from seed. The creepers are sown 3 feet square and the erect covers in rows 3-4 feet apart according to the species. *Vigna* which is shy to seed can be easily reproduced by cuttings or by rooting its runners in a coconut husk containing a compost of soil and "adco".

Recently platforms have been cleared of cover crops and the latter confined to the space between the terraces.

Windbelts of *Gliricidia maculata* have been planted over the entire Station and serve as an excellent and quick-growing wind protection to the youger plants during the monsoon months, while *Albizzia moluccana*, being a bulkier tree, has been utilised to shield gaps and more exposed situations.

NURSERIES

Budwood Nursery.—$2\frac{1}{2}$ acres of "deniya" land have been assigned to a budwood nursery for multiplication of budwood. Here budwood is reproduced of every clone that is being proved at the Station besides others that are likely to be selected. 5 to 7 plants in a group (planted 5 ft. apart) are assigned to each clone as "stocks" and at the first opportunity these "stocks" are budded with wood from the mother tree. In fact when a supply of budwood from a particular clone arrives it is a general rule that the required number of buds for the budwood nursery is reserved. This ensures a reserve supply of wood for subsequent rounds of budding in the field and saves the expense and trouble of sending to estates for wood too frequently.

Budding in the budwood nursery need not be done quite so low down as in field-budding, and any convenient height is permitted. At the Experiment Station 3 feet is the usual height. One or two buds are attached to a plant according as there is budwood available. Directly the budding is found to be successful and the stock is cut down, a tar band is painted immediately below the point of insertion of the bud accompanied by orders to budders that when budwood is taken from the nursery they must cut not less than 1 foot above the tar band. This ensures that (a) budwood and not stockwood is removed and (b) the budwood is cut sufficiently high to allow it to re-extend itself. As, after a time, a budshoot is sometimes easily mistaken for a stockshoot, this precaution has been found very useful.

When the attached bud has begun to shoot, all side shoots which keep on appearing are thumb-nailed off. The terminal bud thus extends with redoubled energy ultimately producing a clean, straight stick of budwood. Moreover too much unchecked growth causes a heavy head of foliage and perhaps damage by wind. Tarring of cuts and accurate labelling is strictly adhered to and cannot be over-emphasised. A chart of the nursery shows each tree in relation to its position, row and clone, and the amount of available budwood in yards. There are at present approximately 124 clones represented in the budwood nursery with "stocks" for many more.

Other Nurseries.—Besides the budwood nursery there are several seedling nurseries containing known as well as unknown "stocks". These are used for budding "supplies" for the field and for purposes of instruction.

A nursery containing 600 seedlings from selected Java seed has been recently opened.

BUDDING ROUTINE AT NIVITIGALAKELE

SEASON

BUDDING is carried out on suitable days between April and December. It is usually stopped if there are 7 consecutive days without rain and also during periods of heavy rain. July, August, and September are regarded as the best months for budding in this district.

TIME

Budding is started as soon after 6 a.m. as possible and continued until 10 a.m. unless the sun is unusually hot. In the afternoons it is continued from 3 p.m. until sunset.

TOOLS, ETC.

The budding tool designed by Mr. R. A. Taylor, of which two sizes are available, is generally used. An ordinary budding knife is used if the budwood is small or does not peel readily. A template is required for marking the stock.

Budding tape, cut into suitable lengths, is wrapped on to small sticks. A note book and indelible pencil should always be carried by the budder.

BUDWOOD

Budwood is at its best after 12-18 months' growth, bright brown in colour, succulent and easy peeling, and 1-2 inches in diameter. Buds from the green part of the stem can also be used quite successfully and in fact frequently give better results on old stocks.

The budwood is sawn from the required tree and for convenience is cut into 1-yard lengths. It is marked in indelible pencil with the clone number in order to avoid mistakes. If not required at once it should be stood with the bottom end in moist sand.

If plenty of budwood is available only branches which are in a state of active growth should be cut, preferably those in which a new whorl of leaves is just appearing.

PREPARING THE STOCK *

The template is held against the tree about 2 inches above the ground and cuts made to the wood on the 2 sides and top. 10-20 trees are cut in this way (more earlier in the morning and less as the sun gets up) and 5 minutes allowed for the latex to dry up before opening the tongue to receive the budpatch.

CUTTING AND INSERTION OF BUD, ETC.

The budpatch containing an undamaged, dormant bud is "lifted" from the budwood by means of the budding tool or else cut off together with a strip of wood by means of the knife. In the latter case the wood is then carefully peeled from the budpatch. The tongue of bark on the stock is carefully opened by the assistant with the spatula of the budding knife, taking care not to damage the cambium. Before opening the tongue the stock plant is thoroughly cleaned with a cloth and any coagulated strands of latex removed.

The budpatch is then carefully inserted, without rubbing, and with its correct side up, the tongue folded over and the whole tightly bandaged with waxed budding tape from bottom to top in the form of a puttee. When large stocks are being budded it is more economical to cover the budpatch with a square of waxed cloth and bind with coir rope.

About half a dozen Rubber leaves are tied in position over the bandage for shade, and a split semicircular piece of bamboo (about 18 inches long) is stuck into the ground opposite and about 1 inch distant from the budpatch to provide additional shelter.

When experimental budding is in progress the clone number should be marked on the stock in indelible pencil as soon as the operation is completed. This is a check that the correct budwood has been used.

EXAMINATION

At the end of three weeks the bandage is removed, the bark flap is cut off and the budpatch examined with the point of a knife. If green at both top and bottom of the patch the budding is regarded as successful.

---

* Since these notes were written a new method of cutting the bud panel, understood to be that used in Malaya, has been employed experimentally. No template is used. Two vertical cuts $1\frac{1}{2}$ in.-2 in. long are made about 1 in. apart and are continued upwards and inwards to meet in a point. The flap is therefore tapered at the top, and is about 3 in. long. The bud-patch is removed as described below and is fitted at the bottom of the panel. When the bud is bound in position the stock flap, being longer and broader than the patch, completely covers the latter so that the edge and tapered portion of the flap fit into their original position thus preventing any movement of the bud-patch. The bandaging is done very tightly, and it is believed that the large flap affords greater protection to the bud-patch if heavy rains are experienced soon after the budding operation. Preliminary tests have shown greater success with this than with the former method, and further comparative trials will be made.—R.K.S.M.

In dry weather the bandage is loosely replaced leaving a small gap over the bud: the patch is reshaded with fresh leaves and the bamboo shade replaced. In wet weather it is better to discard the bandage as rain is liable to lodge behind it.

A second examination is made a week later, and if the bud-patch is still green the bandage and leaves are discarded and the stock is cut at a height of six inches above the budpatch. The bamboo is replaced and allowed to remain until the bud-shoot appears over the top of it. Alternatively a protection basket is placed over the stump and allowed to remain until the first whorl of leaves has developed.

By some planters it is considered preferable to ring-bark about 6 inches above the budpatch and break down the stock at a height of 3 feet. Tests at the Experiment Station showed no advantage for this method but it is proposed to make further tests this year.

CEYLON RUBBER RESEARCH COMMITTEE

A REVIEW OF THE WORK IN LONDON ON THE PLASTICITY OF RUBBER

A VITAL need of the rubber-growing industry is an increased consumption of rubber and all planters are interested in the efforts of the Rubber-Growers' Association to achieve this by propaganda and by the development of new uses. The complementary efforts of the Ceylon Rubber Research Scheme to improve the general suitability of plantation rubber for technical applications are not so well-known and even the planter in Ceylon may find some difficulty in following the logical development of the work. The reason for this difficulty is that the grower is generally too isolated to obtain information easily concerning the properties of rubber which are likely to promote its extended application. Although a periodical review of the work carried out in London is given in each annual report of the Scheme it is considered that there is a need for a more popular and discursive review which would enable the grower to take an interest in the work and secure his practical co-operation when this is necessary for ultimate success.

The present review is the first of a series. It is intended that each shall be confined to one subject and shall only be issued when the results of investigations or other circumstances render the subject sufficiently ripe for explanation.

The investigations on the plasticity of rubber have made considerable progress and further developments are partly dependent upon the active co-operation of the rubber-grower. Accordingly plasticity has been selected as the subject of the first review, the aim of which is to inform the planter of the practical objects of the work, the extent of the progress made, and what further work is planned.

1. THE OBJECTS OF THE WORK ON PLASTICITY

Many efforts have been made and continue to be made by the staff in London to ascertain what mechanical and chemical properties restrict the use of rubber and what improvements can be made to promote an increased consumption. This is not a simple matter because rubber is used for such a variety of purposes and under such widely different conditions that a rigid specification is generally agreed to be impracticable, but

all the techinical experts consulted are of opinion that raw rubber should be uniform and as soft as possible without sacrificing its technical value in other directions.

The demand for a soft rubber arises from the fact that a hard rubber is difficult and in some cases impossible to manipulate in manufacturing operations. This is a principal reason why reclaim is an important competitor of plantation rubber and is also a cause of demand for lower grades of rubber. Both reclaim and lower grades of rubber are soft and when mixed with plantation rubber enable it to pass through processes where without their aid considerable difficulty would be experienced. In the manufacture of cheap articles where powders are merely held together by a binding material any commodity which is able to perform this binding function and which is at the same time cheaper than first grade rubber is bound to have a market. There is no doubt however from the statistics of the rubber industry that off grades and reclaim are used extensively in tyres and other articles. Some manufacturers (particularly those whose reputation for quality is a valuable asset) consider that it is bad practice to replace first grade rubber with inferior grades. There are others however who cater for a different market and aim at making a cheap article with quality a secondary consideration. In these cases the material is used not merely because the first cost is less but also because first grade rubber is strong and nervy and renders manufacturing operations more difficult and expensive. If first grade plantation rubber were as soft as reclaim the only advantage of using the latter would be one of price, and if the softness of plantation rubber were obtained without sacrificing its superior quality in other directions the scales would be far less heavily loaded against first grade plantation rubber.

It will probably be a surprise to many planters to learn that the interests of the growers are associated with the production of soft rubber. Planters are compelled by market standards to prepare rubber which is hard and nervy. Market standards at present are not correlated closely with the technical requirements of the industry, but the information acquired in London indicates that if manufacturers could be assured of a continuous supply of uniformly soft rubber with satisfactory properties in other directions, market standards would automatically adjust themselves to the demand which would arise.

The object of the work in London on plasticity may be summarised therefore as the production of a uniformly soft crepe and sheet without sacrificing technical properties in other directions so as to extend considerably the market for first grade material.

2. PROGRESS OF THE INVESTIGATIONS

(a) *Method of test.*—Owing to the small amount of attention previously devoted to the subject by rubber investigators it was first necessary to study methods for determining the plasticity of rubber and some time elapsed before a practical test could be devised. Special machines for a practical test on the plasticity of plantation rubber were in use in some rubber works but numerous difficulties and doubts required study before they could be adopted to the requirements of investigators on behalf of the planter. During the last two years a method has been standardised for the routine examination of samples. Several manufacturers have taken an interest in the method developed by the London staff of the Scheme and have sought their advice before establishing tests for the control of plasticity in their own works.

(b) *Effect of modification of methods of preparation.*—While the methods for the determination of plasticity were under investigation a study was commenced by such methods as were available of the effect on plasticity of modifications of the usual method of preparing rubber. On the whole these results did not help greatly to suggest a method by which uniformly soft rubber might be prepared because none of the modifications tried had a marked effect. The preparation of crepe from very dilute latex (5 per cent. dry rubber content) led to the production of soft rubber, as also did rolling the rubber from 20 to 40 times, but these effects are merely of academic interest, the real practical conclusion being that definitely soft rubber could not be obtained without going to extremes in the way of dilution or rolling.

The most interesting feature of the study of methods of preparation was the fact that the addition of bisulphite to latex caused the resulting crepe to he harder than it otherwise would be. Accordingly it may be concluded that although the addition of bisulphite to latex is necessary to satisfy market standards, yet its use is a mixed blessing as it increases the hardness of rubber.

De Vries in Java also found that the methods of preparation had little effect on the hardness of freshly prepared rubber but he stated that the hardness of some rubbers changed considerably on keeping. When more than the usual amount of serum substances was present the rubber became hard and when less was present the rubber became soft.

(c) *Effect of storage.*—A study was therefore commenced in London by the Ceylon Rubber Research Scheme of the effect of different conditions of storage on the hardness of rubber and

this study has been productive of valuable information as to the cause of hardening and softening of rubber. When rubber is stored in a dry inert atmosphere such as nitrogen in the complete absence of oxygen it becomes very hard, the rate and extent of the change depending upon temperature. When rubber is stored in air and therefore in the presence of oxygen it always remains softer than in nitrogen, although at temperatures below 30°C (tropical temperature) it may harden and at higher temperatures it usually becomes softer. These experiments (which are still proceeding so as to elucidate the details of the changes which occur when rubber is kept for a short or long time under different conditions), indicates that rubber has a natural tendency to harden on keeping, but that this tendency is restrained by oxygen and that in certain circumstances when oxidation is more rapid than usual the rubber becomes soft.

(d) *Variability of estate rubber.*—In addition to these studies an investigation has recently been completed of the extent of variation in the hardness of crepe and sheet from practically every estate in Ceylon when kept under the same conditions. These results show that there is a considerable variation, much larger than can be produced by reasonable modifications of the method of preparation, but of course less than can be produced by keeping the same sample of rubber under different conditions. It is concluded that the latex from some trees contain substances which render the rubber particularly resistant to oxidation (antioxidants) and that the rubber from these trees becomes hard on keeping for a few months at about 15°C. Similarly the latex from other trees is deficient in these substances (antioxidants) and the rubber becomes soft on keeping owing to oxidation. In this connection it is of interest that bisulphite is added to latex in crepe preparation to restrain discolouration of the coagulum by oxidation, and it is therefore no longer surprising that it has a hardening effect upon crepe. Similarly the observation of de Vries that rubber containing more than the usual amount of serum substances (and therefore of natural antioxidants) becomes hard and rubber with less than the usual amount becomes soft is in agreement with the theory that rubber naturally becomes hard except in so far as it is restrained by oxidation.

3. FURTHER WORK

In view of the fact that it has been found that oxidation is the principal agent causing softness, the question now arises as to whether it is possible to soften rubber by oxidation without decreasing its technical value. There is no doubt that pronounced oxidation under some circumstances renders the rubber

unfit for classification as first grade material. It does not follow however that mild oxidation, such as appears to occur on keeping average samples of crepe and sheet, is harmful. To obtain further information on this question it is proposed to determine the technical value of rubber from estates producing soft material in comparison with that of rubber from estates producing hard material. It has already been shown that there is little seasonal variation in the hardness of rubber and as already explained samples of rubber were recently examined from practically every estate in Ceylon. It is expected that further supplies of rubber from estates which supplied hard or soft samples will enable comparisons to be made of the technical value of hard and soft rubbers. It is also hoped that Mr. O'Brien will be able to study the methods of preparation employed on these estates to ensure that some departure from the usual process is not responsible for the abnormality.

It is impossible to forecast with accuracy the ultimate practical outcome of this work, but it may take the following forms:

1. The preparation throughout Ceylon of a uniformly soft rubber with excellent technical properties. This may be achieved in a number of ways requiring further study.

2. If it is found that mildly-oxidised rubber cannot have the same technical value as a hard rubber, it may be necessary to consider the addition of antioxidants to latex so as to produce a rubber of enhanced technical value as compared with average crepe or sheet. This rubber would be hard (and preliminary experiments with preserved latex have confirmed this) but it undoubtedly would be of value for crepe soleing and its enhanced technical value over ordinary crepe and sheet might promote its use for other purposes. There would then be two classes of rubber, viz., (1) a hard rubber with otherwise excellent technical properties, (2) a somewhat inferior soft rubber more suitable for manipulation.

3. The natural hardening of rubber requires further study, as if this can be restrained it may be possible to prepare rubber which remains soft without oxidation.

It is obvious that the investigations on plasticity have now reached an interesting stage. Success of a practical character is within sight but a considerable amount of work remains to be done before it can be brought to a definite conclusion.

G. MARTIN.

Imperial Institute,
London, S.W. 7.
July, 1931.

RUBBER RESEARCH SCHEME (CEYLON)

LIST OF PUBLICATIONS FOR SALE.

Bulletins at Re. 1-00 per copy.

No. 1. The Effect of Tapping on the Movements of Plant-Food in Hevea brasiliensis.
No. 2. The Effect of Tapping on the Movements of Plant-Food in Hevea brasiliensis.
No. 3. Seasonal Variations in the Movements of Plant-Food in Hevea brasiliensis Part I.
No. 4. The Physiological Effects of Various Tapping Systems, Part I.
No. 5. Progress Report on Vulcanization Tests
No. 6. The Physiological Effects of Various Tapping Systems, Part II.
No. 7. Do Do Do Part III
No. 8. Seasonal Variations in the Movements of Plant-Food in Hevea brasiliensis, Part II.
No. 9. Vulcanization Tests.
No. 10. Do.
No. 11. Variability in Rubber Manufacture.
No. 12. Progress Report of the Rubber Research Chemist.
No. 13. Vulcanization Tests.
No. 14. On the Variation in the Number of Latex Vessels present in Hevea brasiliensis.
No. 15. Vulcanization Tests.
No. 16. On the Natural Clotting of Rubber Latex.
No. 17. Vulcanization Tests.
No. 18. Measurements of "Bark Renewal."
No. 19. Vulcanization Tests.
No. 20. Do.
No. 21. Do.
No. 22. Do.
No. 23. Do.
No. 24. Do.
No. 25. Investigations on Samples of Plantation Para Rubber from Ceylon.
No. 26. Results of Trials of Ceylon Plantation Rubber for the manufacture of Ebonits.
No. 27. Investigations on Samples of Plantation Para Rubber from Ceylon.
No. 28. Do.
No. 29. Summary of the Principal Results obtained from Investigations into the Properties of Ceylon Plantation Rubber in relation to its Method of Preparation.
No. 30. The penetration of disinfectant on the tapping cut of Hevea brasiliensis.
No. 31. On the Occurrence of "Rust" on Sheet Rubber.
No. 32. On the Preservation of Latex.
No. 33. Investigations on Samples of Plantation Para Rubber from Ceylon.
No. 34. Do.
No. 35. Do.
No. 36. Do.
No. 37. Do.
No. 38. Do.
No. 39. Do. (Final Report Series I.)
No. 40. Do Series II.
No. 41. Do. First Interim Report on artificial ageing tests.
No. 42. On the Smoking of Sheet Rubber in relation to Mould Prevention.
No. 43. The inter-relationship of Yield and the various Vegetative Characters in Hevea brasiliensis.
No. 44. The Construction of Smokehouses for Small Rubber Estates.
No. 45. The Efficiency of Disinfectants and Fungicides.
No. 46. The Control of Bark Rot by Disinfectants.
No. 47. Report on Variability of Ceylon Estate Grades.
No. 48. Brown Bast and its Treatment.
No. 49. Report on Causes of Variation in Plasticity.
No. 50. Crepe Rolling.
No. 51. The Curing of Sheet Rubber.

Booklets at Rs. 2-50 per copy.

Guide to the Preparation of Plantation Rubber, by T. E. H. O'Brien, M.Sc., A.I.C., Chemist.
The Budding of Rubber, by R. A. Taylor, B.Sc., Physiological Botanist.
Diseases of Rubber in Ceylon, by R. K. S. Murray, A.R.C.Sc., Mycologist.